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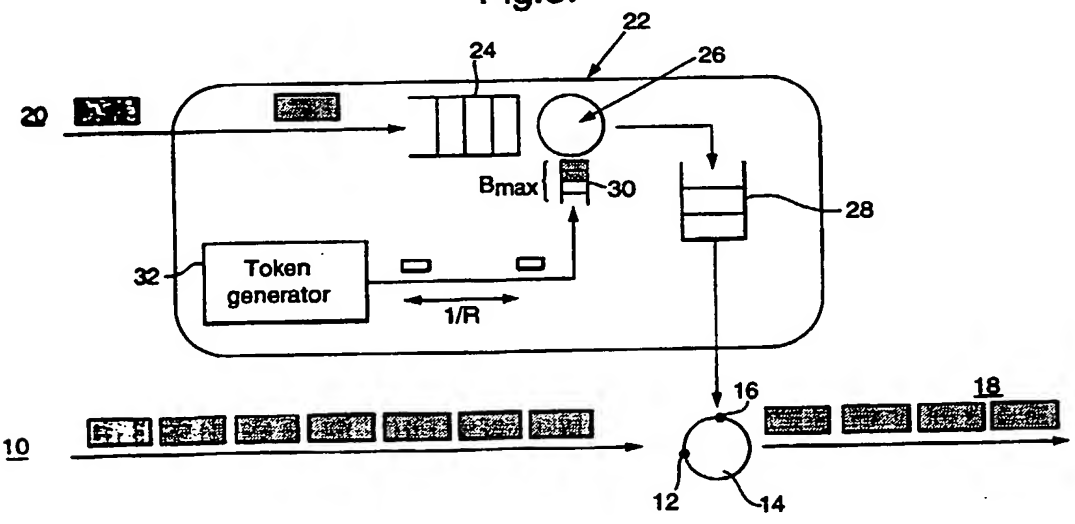
(54) Abstract Title
Telecommunications systems and methods

(57) In a telecommunications system, an input flow (10) of speech packets arrives. In addition, an input flow (20) of high priority packets (e.g. signalling packets) arrives intermittently. The high priority packets are to be inserted into the flow of speech packets to produce an output flow (18), in which the high priority packets are inserted into time slots previously occupied by speech packets. A "leaky bucket" algorithm (30,32) is used to control the insertion of the high priority packets into the output flow so that a burst of the high priority packets, up to a predetermined maximum size, can be inserted. In addition, it is ensured that at least N speech packets remain in the output flow between two consecutive higher priority packets therein. Insertion of a high priority packet can cause a speech packet to be discarded (deleted) or, instead, can simply delay all the speech packets by one time slot.

Fig.3.



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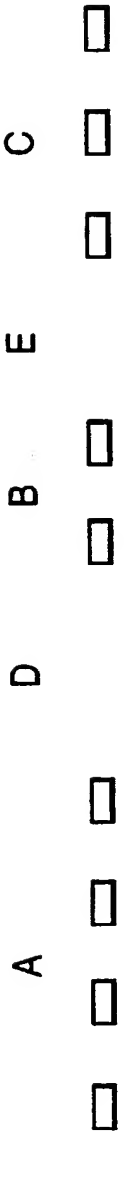


Fig.1.

Fig.2.

Fig.3.

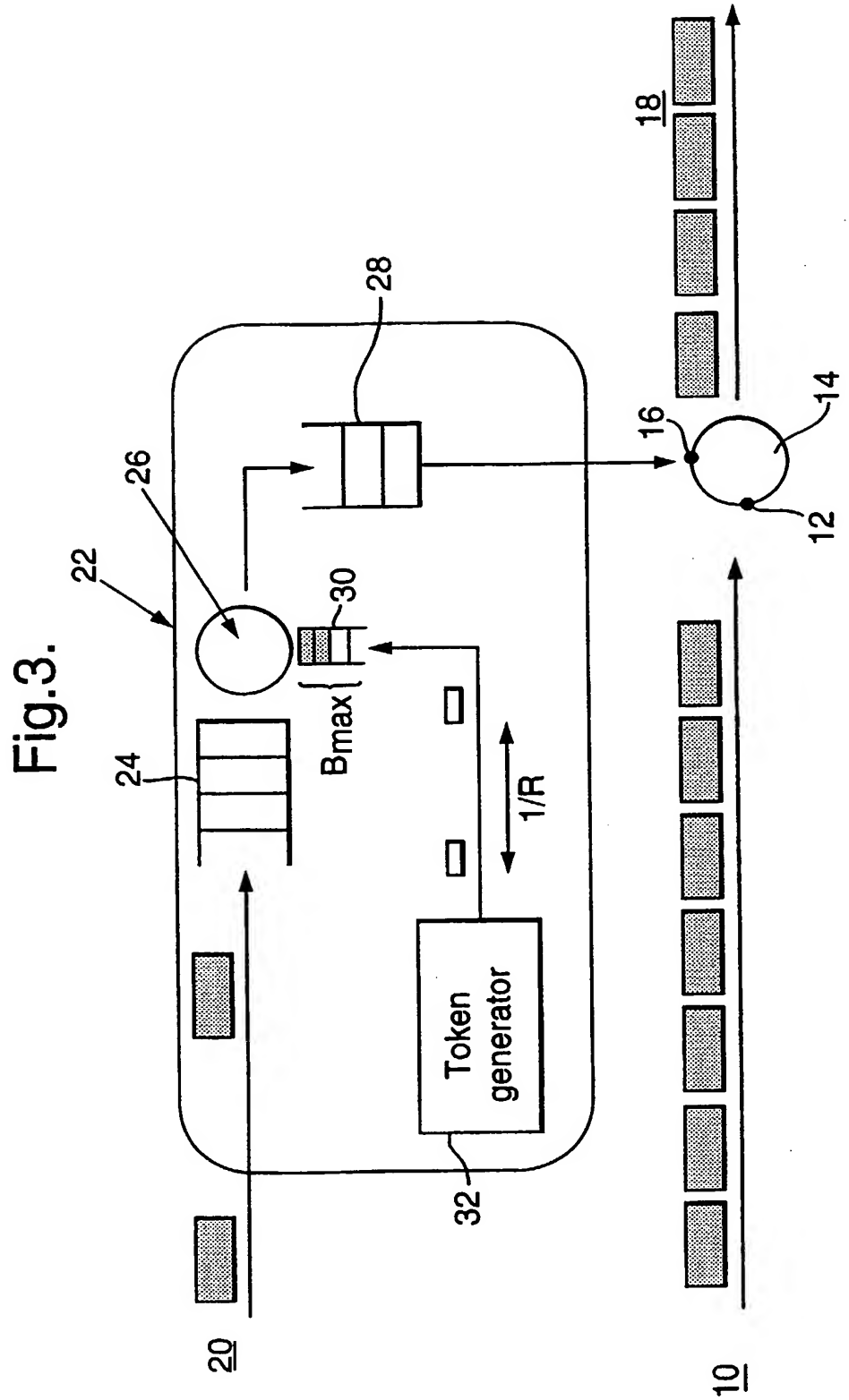
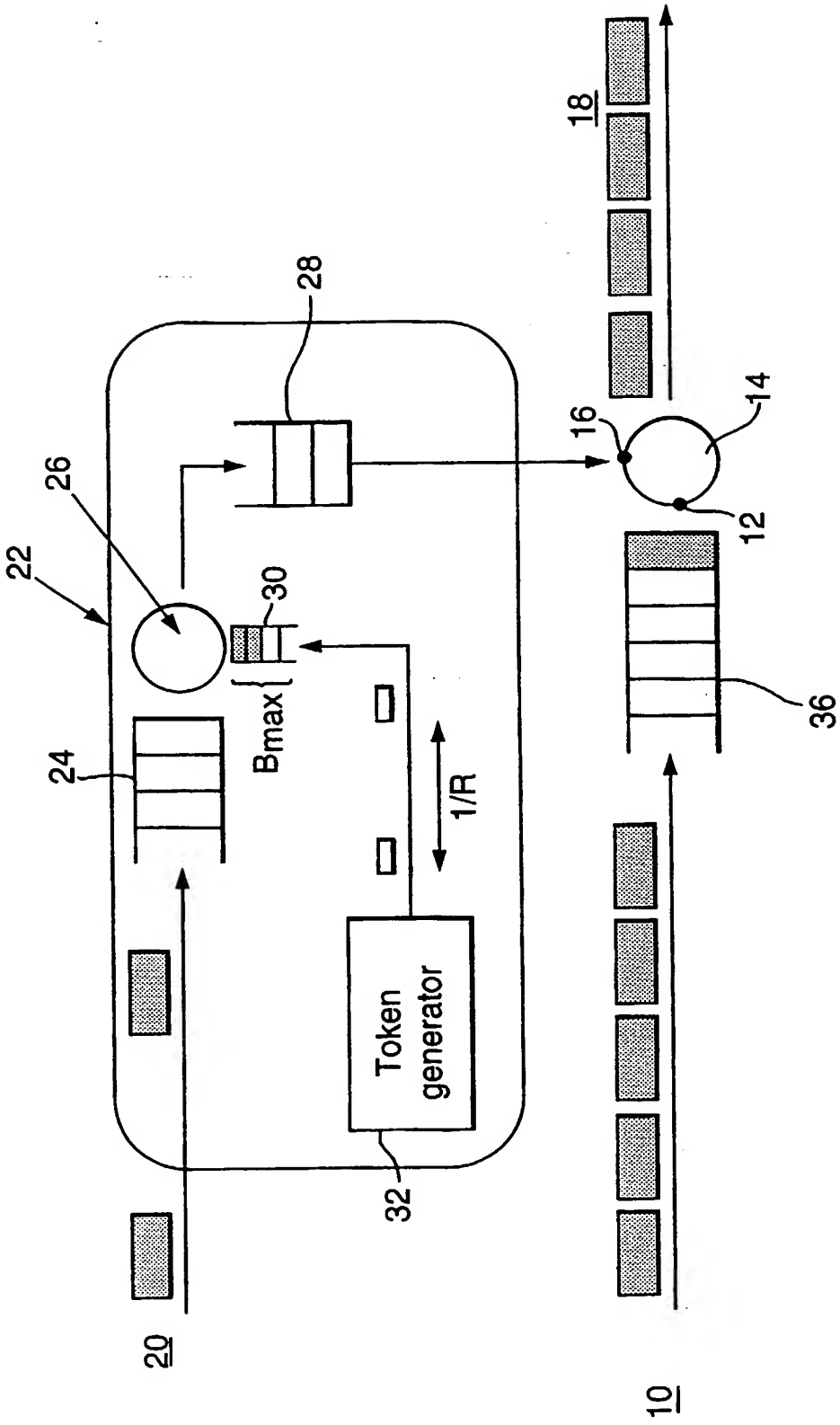


Fig.4.



TELECOMMUNICATIONS SYSTEMS AND METHODS

The invention relates to telecommunications systems and methods. In embodiments of the invention to be described in more detail below, by way of example only, the transmission of information of a first type is interrupted in a controlled way to allow the transmission of information of a second type (for example, having a higher priority).

According to the invention, there is provided a telecommunications system, having a first input for receiving a flow of first information packets serially presented in consecutive time slots occurring at a first predetermined rate, a second input for receiving a second flow of information packets intermittently presented, and control means responsive to the second information packets for inserting each one into the flow of first packets in a respective time slot therein instead of the first information packet occupying that time slot to produce an output flow, the control means comprising feeding means for normally so inserting the second information packets at a rate not more than a predetermined maximum rate but permitting not more than a predetermined plurality of successive second information packets to be so inserted at an enhanced rate higher than the predetermined maximum.

According to the invention, there is also provided a telecommunications method, comprising the steps of (a) receiving a flow of first information packets serially presented in consecutive time slots occurring at a first predetermined rate, (b) receiving a second

flow of information packets intermittently presented, and (c) responding to the second information packets by inserting each one into the flow of first packets in a respective time slot therein instead of the first information packet occupying that time slot to produce an output flow, the second information packets being normally so inserted at a rate not more than a predetermined maximum rate but not more than a predetermined plurality of successive second information packets being permitted to be so inserted at an enhanced rate higher than the predetermined maximum.

Telecommunications systems and methods according to the invention will now be described, by way of example only, with reference to the accompanying diagrammatic drawings in which:

Figure 1 shows packets of service information being transmitted in one of the systems;

Figure 2 shows packets of higher priority information being transmitted in the system;

Figure 3 is a block diagram of one of the systems, receiving flows of information packets of the types shown in Figures 1 and 2; and

Figure 4 is a block diagram of a modified form of the system of Figure 3.

Figure 1 shows a typical flow of information packets in a telecommunications system, in

particular in a telephone system such as a cellular telephone system of the GSM type. The information packets in Figure 1 are "service" packets – that is, they are packets of the information which the system is designed to transmit to perform the service required by its users. For example, they can represent speech. These packets will be transmitted at a constant rate (S) during periods A,B,C..... of variable length separated (in the case of speech) by periods of silence as shown at D,E.....; that is, the system defines a series of time slots occurring at a rate S, each time slot comprising one speech packet during a period of speech transmission.

In such a system, it is also necessary to transmit higher priority information packets intermittently, and this higher priority information is shown diagrammatically in Figure 2. This higher priority information may comprise signalling or control information, for example, and will arrive intermittently and possibly in bursts.

The systems and methods to be described enable the transmission of the lower priority packets shown in Figure 1 to be interrupted to allow transmission of the higher priority packets shown in Figure 2. It is implicit in this process that the system can be tolerant to a limited loss of the packets shown in Figure 1, and this is true in the case where the information shown in Figure 1 comprises speech packets. However, the amount of loss of speech packets information which can be permitted is limited. The systems and methods to be described facilitate the control of the amount of such loss, at the same time optimising the transmission of the higher priority information packets of the type shown

in Figure 2. Although the following description refers to the lower priority packets as speech packets, it will be understood that they need not be packets of this type.

As shown in Figure 3, the system has an input 10 which receives the service information packets (that is, the speech packets in this example), which arrive at the constant rate (S) during the periods of activity A,B,C..., separated by periods D,E... of inactivity or silence. The speech packets arriving on the input 10 are fed to one input 12 of a gate device 14. The gate device 14 has a second input 16 which receives the higher priority packets. The gate device responds to receipt of each higher priority packet by discarding one speech packet and replacing it with the higher priority packet. The gate device 14 therefore produces an output flow 18 comprising packets occurring in respective time slots having the same rate (S) as in the input flow but which includes high priority packets interspersed with the speech packets.

The higher priority packets arrive intermittently on an input 20. In view of their priority, it is desirable that each such packet be transmitted within the output flow 18 as soon as possible. However, each such packet will displace one of the speech packets, thus at least slightly degrading the speech output. The degree of such degradation must be limited and it is therefore necessary to control the manner in which the high priority packets displace the speech packets. This control is performed by a control arrangement 22, now to be described.

The control arrangement 22 operates using a so-called "leaky bucket" algorithm. The higher priority packets arriving on the input 20 are fed into an input queueing arrangement 24. A gating arrangement 26, controlled by the leaky bucket algorithm in a manner to be explained, controls the onward passage of each high priority packet from the queueing arrangement 24 to an output queue 28 and thence to the gate device 14.

The leaky bucket algorithm comprises a dynamic store or "bucket" 30 which receives and holds "tokens". Tokens are produced at a constant rate R by a token generator 32. Normally, R will be a sub-multiple of S. The store 30 has a maximum capacity B_{max} - that is, this is the maximum number of tokens which it can store at any time. If it is full, further tokens arriving from the token generator 32 are simply discarded. The gating arrangement 26 requires one token from the store or bucket 30 to allow one higher priority packet in the queueing arrangement 24 to pass through to the output queue 28, and each such packet passing through the gating arrangement 26 "consumes" or removes that token from the store 30. If the store 30 contains several tokens, and a corresponding number of high priority packets arrive on the input 20, they can thus be passed rapidly through the gating arrangement 26 (that is, their rate of transmission is not restricted to R). Thus, the maximum number of higher priority packets which can be passed through in this manner will correspond to B_{max}. When the bucket 30 has been completely emptied, the next higher priority packet arriving on the input 20, or already present in the queueing arrangement 24, cannot be passed through the gating arrangement 26 until the next token arrives from the token generator 32. In this way, therefore, a "burst" of high priority data

packets queued in the queueing arrangement 24 or arriving there if the queueing arrangement is wholly or partially empty, can be passed rapidly through the gating arrangement 26 if there are sufficient tokens already held in the store 30, but once the bucket has been emptied by such a burst of higher priority packets, they can thereafter pass through the gate 26 at a maximum rate corresponding to the rate R at which the tokens are produced by the token generator 32. Of course, if there is a sufficiently long period in which no higher priority packets arrive on the input 20, the bucket 30 will become re-filled with tokens, or at least partially re-filled, ready to allow another burst of data packets to pass through the gating arrangement if such a burst occurs.

Higher priority packets pass from the output queue 28 to the control unit 32 and each replaces a respective one of the speech packets in the output flow 18. The higher priority packets exiting the output queue 28 are thus in phase with the time slots in the output flow 18. The output queue 28 could be arranged (if it receives sufficiently frequent higher priority packets) to allow such higher priority packets to replace consecutive speech packets in the output flow 18. However, this is unlikely to be acceptable in practice because it could result in the discarding of several consecutive speech packets, which might render the speech output unintelligible or at least unsatisfactory. It is therefore desirable that a limit be placed on the minimum number (N) of time slots between any two speech packets into which higher priority packets can be inserted. For example, N may equal 1, so that it is not possible for two consecutive speech packets to be deleted - in other words, there is always at least one speech packet between two consecutive high

priority packets in the output flow. In effect, this means that higher priority packets cannot be supplied to the gate 14 at a rate higher than half the rate of occurrence of the time slots in the output flow 18. This can be ensured by means of the output queue 28. The output queue 28 can be considered as having a number of queueing locations, the content of each of which is passed in turn to the gate 14, at the rate S. If, under operation of the store 30 in the manner explained above, a higher priority packet is placed into a queueing location in the output queue 28, the output queue automatically ensures that the immediately following N queueing locations are empty - so that they do not become filled with another higher priority packet even if one is immediately output by the gate 26. In this way, therefore, it is ensured that two consecutive speech packets cannot be discarded.

In principle, though, N could be O if the flow of lower priority packets is not significantly prejudiced.

The operations described above are the operations applicable during a period when speech packets are arriving - such as shown at A,B or C in Figure 1. During "silence" periods as shown at D and E for example, there need be no limitation on the insertion of the high priority packets into the output flow 18. In other words, the control arrangement 22 is "inactive". In addition, the bucket 30 is considered to be full at the end of each silence period (corresponding to the beginning of the next speech period). The bucket can also be considered to be full when the system is initialised.

In the system as described above, each higher priority packet arriving at the gate 14 causes one of the speech packets to be discarded (or deleted). Figure 4 shows a modified arrangement in which items corresponding to those in Figure 3 are similarly referenced. In the system of Figure 4, the incoming lower priority packets are not fed directly to the gate 14 but are fed to the gate 14 via a queue 36 from which they are fed in turn to the gate 14. Each higher priority packet arriving at the gate 14 from the output queue 28 in this case does not discard the next-arriving lower priority packet but instead causes that packet to be held temporarily (for a period 1/S) in the first queueing location in the queueing arrangement 36, the immediately following packet similarly being delayed. In effect, all the packets in the queueing arrangement 36 are moved backwards by one queueing location. It may not be possible to operate such a queueing and delaying system with some types of lower priority packets; indeed it may not be possible when the lower priority packets are speech packets.

The systems and methods described are advantageous in that they control how the higher priority packets discard or delay lower priority packets. In particular, the systems and methods enable a "burst" of higher priority packets (up to the maximum capacity of the bucket 30) to be inserted into the output flow. In addition, it is ensured that the output flow always contains at least N lower priority packets following each inserted higher priority packet.

In a modification of the systems described, the higher priority packets could be of

different types, perhaps arriving in parallel with each other, and each such type may be allocated different values of one or more of the control parameters B_{max}, R and N.

CLAIMS

1. A telecommunications system, having a first input for receiving a flow of first information packets serially presented in consecutive time slots occurring at a first predetermined rate, a second input for receiving a second flow of information packets intermittently presented, and control means responsive to the second information packets for inserting each one into the flow of first packets in a respective time slot therein instead of the first information packet occupying that time slot to produce an output flow, the control means comprising feeding means for normally so inserting the second information packets at a rate not more than a predetermined maximum rate but permitting not more than a predetermined plurality of successive second information packets to be so inserted at an enhanced rate higher than the predetermined maximum.

2. A system according to claim 1, in which the predetermined maximum rate is less than the said first predetermined rate.

3. A system according to claim 2, in which the enhanced rate is not more than the first predetermined rate.

4. A system according to claim 2 or 3, in which the predetermined maximum is a sub-multiple of the first predetermined rate and defines time slots each of which is in phase

with a respective time slot in the first flow.

5. A system according to any preceding claim, in which the control means includes limiting means for ensuring that second information packets are not present in consecutive ones of the time slots in the output flow.

6. A system according to claim 5, in which the limiting means comprises means for ensuring at least N time slots occupied by first information packets in the output flow between any two time slots therein respectively occupied by second information packets.

7. A system according to any preceding claim, in which the control means comprises timing means defining gating time slots occurring at a rate corresponding to the said predetermined maximum rate, the feeding means comprising gating means for receiving the second information packets and controlled by the timing means to be open for each gating time slot to allow the passage of a respective one of the second information packets, and override means operative in the absence of any second information packets during the occurrence of not more than a number of the gating time slots corresponding to the said predetermined plurality to open the gating means and allow the passage therethrough of not more than that number of second information packets at the enhanced rate.

8. A system according to claim 7, in which the gating means is operative under

control of a leaky bucket algorithm.

9. A system according to any preceding claim, in which the said flow of first information packets is followed by a period during which no first information packets are presented, and in which the feeding means is operative during that period to permit any plurality of successive second packets to be inserted into the first flow.

10. A system according to any preceding claim, in which any first information packet in a time slot in the first flow into which a said second information packet is inserted instead of that first information packet never appears in the output flow.

11. A system according to any one of claims 1 to 9, in which the insertion of a said second information packet into the time slot in the first flow instead of the first information packet occupying that time slot causes that first information packet to be delayed until a later time slot.

12. A system according to any preceding claim, in which the first information packets are speech packets and the second information packets are signalling information packets.

13. A telecommunications system, substantially described with reference to the accompanying diagrammatic drawing.

14. A telecommunications method, comprising the steps of (a) receiving a flow of first information packets serially presented in consecutive time slots occurring at a first predetermined rate, (b) receiving a second flow of information packets intermittently presented, and (c) responding to the second information packets by inserting each one into the flow of first packets in a respective time slot therein instead of the first information packet occupying that time slot to produce an output flow, the second information packets being normally so inserted at a rate not more than a predetermined maximum rate but not more than a predetermined plurality of successive second information packets being permitted to be so inserted at an enhanced rate higher than the predetermined maximum.

15. A method according to claim 14 in which the predetermined maximum rate is less than the first predetermined rate.

16. A method according to claim 15, in which the enhanced rate is not more than the first predetermined rate.

17. A method according to claim 15 or 16, in which the predetermined maximum is a sub-multiple of the first predetermined rate and defines time slots each of which is in phase with a respective time slot in the first flow.

18. A method according to any one of claims 14 to 17, including the step of ensuring that second information packets are not present in consecutive ones of the time slots in

the output flow.

19. A method according to any one of claims 13 to 17, including the step of ensuring at least N time slots occupied by first information packets in the output flow between any two time slots therein respectively occupied by second information packets.

20. A method according to any one of claims 14 to 19, in which step (c) comprises the steps of defining gating time slots occurring at a rate corresponding to the said predetermined maximum rate, permitting the passage of a respective one of the second information packets for each gating time slot, and in the absence of any second information packets presented during the occurrence of not more than a number of the gating time slots corresponding to the said predetermined plurality permitting the passage of not more than that number of second information packets at the enhanced rate, each second information packet whose passage is permitted being inserted into the flow of first packets in a respective time slot therein instead of the first information packet occupying that time slot to produce the output flow.

21. A method according to any one of claims 14 to 19, in which step (c) is controlled by a leaky bucket algorithm.

22. A method according to any one of claims 14 to 21, in which the said flow of first information packets is followed by a period during which no first information packets are

presented, and including the step operative during that period to permit any plurality of successive second packets to be inserted into the first flow.

23. A method according to any one of claims 14 to 22, in which any first information packet in a time slot in the first flow into which a said second information packet is inserted instead of that first information packet never appears in the output flow.

24. A method according to any one of claims 14 to 22, in which the insertion of a said second information packet into the time slot in the first flow instead of the first information packet occupying that time slot causes that first information packet to be delayed until a later time slot.

25. A method according to any one of claims 14 to 24, in which the first information packets are speech packets and the second information packets are signalling information packets.

26. A telecommunications method, substantially as described with reference to the accompanying diagrammatic drawings.

Application No: GB 0107356.8 **Examiner:** Gary Williams
Claims searched: 1-26 **Date of search:** 10 December 2001

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.S): H4K: KTKX

Int Cl (Ed.7): H04L: 12/56,29/06; H04Q: 11/04

Other: Online:EPODOC,PAJ,WPI

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
A	GB 2348344 A	(MOTOROLA) See Fig.9, abstract, page 3 line 30 - page 7 line 2, claims 1,6	1,14
A	GB 2166320 A	(STC) See Figs.1-3, page 1 line 49 - page 2 line 80	1,14
A	WO 00/20876 A1	(GENERAL DATACOMM) See Fig.4, page 2 lines 19-24, pages 12 lines 1-16, claims 1,7	1,14
A	WO 95/12265 A1	(NORTHERN TELECOM) See Figs.2-4, abstract, page 4 line 34 - page 5 line 10, page 6 line 21 - page 8 line 17	1,14
X	JP 2001024702 A	(NIPPON ELECTRIC) 26.01.01 (See Fig.1, and also WPI Abstract Accession No. 2001-199027/20.)	1,14 at least

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.